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ORIGINAL CONTRIBUTIONS

Weight Loss, Remission of Comorbidities, and Quality of Life After Bariatric Surgery in Young Adult Patients

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Abstract

Introduction One of the current criteria for bariatric surgery is to be of an age between 18 and 65 years. In all the available literature, there is a lack of studies focusing on the results of bariatric surgery in younger patient. This could be of great interest because the weight loss response can be altered by differences in metabolism or compliance rate. In recent years, a high amount of patients between 18 and 25 years of age have undergone bariatric surgery in our center, and it is our aim to evaluate the weight loss results in this youngest patient group.

Methods All preoperative and perioperative data from patients aged 18–25 and 35–55 years (control group) were collected retrospectively. Bariatric procedures took place between 2011 and 2014. Follow-up data were gathered prospectively by collecting (laboratory) measurements and questionnaires.

Results In total, 103 young adults (mean age 22.5) were matched to 103 adult control patients (mean age 42.6) on BMI and date of surgery. Of the young adults' group, 75 patients underwent a Roux-en-Y gastric bypass (RYGB) compared with 80 patients in the control group. Three years after RYGB, mean %total body weight loss (%TBWL) was 34 (± 9) and 30.3 (± 9) ($p = 0.03$), respectively.

Conclusion Bariatric surgery is effective in young adults, and results after RYGB are even better compared with age groups in which bariatric surgery is most often performed. The high remission rate of comorbidities shows the importance of effective treatment options at a young age and preventing damaging effects in the long term.

Keywords Bariatric surgery · Obesity · Young adults · Gastric bypass · Sleeve gastrectomy

Introduction

The continuous growth of the worldwide obesity epidemic is not limited to a specific age group; not only adults are becoming more obese, but the rate of reported childhood obesity is also increasing. Obesity at an early age is associated with an increased risk of coronary heart disease during adulthood—especially in men—and an increased premature death risk, especially in younger and middle-aged women [1, 2]. Additionally, the earlier onset of obesity-related comorbidities, such as type 2 diabetes mellitus in childhood and adolescence, will lead to an earlier onset of related medical complications and treatment resistance [3, 4]. Approximately 80% of obese children are expected to be obese in adulthood, illustrating the importance of effective treatment options to induce durable weight loss and improvement of obesity-related comorbidities at an early stage [1, 5]. The current age criteria for bariatric surgery are between 18 and 65 years. The available literature shows that differences in weight loss response are already reported, in favor of patients with an age < 50 years, compared with the elderly [6]. There is however a lack of studies focusing on the weight loss results of younger-aged patients' groups. This could be of interest to us, due to possible differences in metabolism and compliance rate, altering the weight loss pattern. In the last 10 years, a large number of patients between 18 and 25 years of age underwent bariatric surgery in our center. We hereby evaluate the weight loss results after different bariatric procedures in what is currently the youngest patient group.

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Methods

Participants and Study Design

All patients with an age between 18 and 25 years at the time of their primary bariatric procedure, Roux-en-Y gastric bypass (RYGB), or sleeve gastrectomy (SG) were collected retrospectively. To be able to compare weight loss outcomes and remission rates of comorbidities, we composed a control group with patients aged between 35 and 55 years. These bariatric patients represent the group with the average age in our clinic (42 years). The patients in the control group were matched for preoperative BMI (calculated as weight in kilograms divided by height in meters squared), date of surgery, and therefore also for surgeon. Missing follow-up data and revisional surgery were exclusion criteria. All RYGB and SG procedures were performed between 2010 and 2014, ensuring at least 3 years of follow-up.

Preoperative, perioperative, and immediate postoperative data were gathered retrospectively from the medical files. Follow-up data were collected prospectively through medical and quality of life questionnaires (Short Form-36 questionnaire) and laboratory measurements.

This study was approved by the national ethical committee and the local institutional review board. Written informed consent was obtained from all participants.

Secondary Outcomes

As a secondary aim of this study, we determined the remission rates of diabetes, hypertension, or dyslipidemia. Remission of diabetes, hypertension, or dyslipidemia was defined as the rate of patients who were able to discontinue all anti-diabetic, antihypertensive, and lipid-lowering medication, for at least 2 years after surgery. Unfortunately, levels of fasting glucose or glycated hemoglobin A_{1c} (Hba_{1c}) were not available for the majority of patients during follow-up because most patients are referred back to either their general practitioner or endocrinologist 3 months after surgery. Patients with type 1 diabetes mellitus were excluded from the analyses.

Another secondary aim of this study was the incidence of vitamin deficiencies, which were defined as a value below the lower limit of normal ranges according to the laboratory references stated by the American Society for Metabolic and Bariatric Surgery (ASMBS). These values are presented in the accompanying table.

Although weight loss is a practical endpoint to measure the success of metabolic surgery, in daily life, the real aim is to improved health, life expectancy, and quality of life. Quality of life measurements not only illustrate the effect of weight loss from a patient's perspective but also underline the importance of this type of treatment. Therefore, we also determined quality of life scores during follow-up, using the SF-36 questionnaire.

Procedures

Laparoscopic Roux-en-Y gastric bypass surgery was performed in a standardized fashion, by creating a gastric pouch with a volume of 30 to 50 mL, followed by an alimentary and biliopancreatic limb with lengths of 150 and 50 cm, respectively. Both mesenteric defects were closed with a double layer of hernia staples. Laparoscopic sleeve gastrectomy surgery was also performed in a standardized fashion by performing a longitudinal resection of the stomach by using a 40 French catheter, which is used as bougie for the correct diameter.

Assessment

Prior to surgery, patients followed a standardized health program in multiple sessions, focusing on lifestyle changes, physical activity, nutrition, and motivation. This program was resumed after surgery with multiple sessions during the following 6 years. According to the guidelines of bariatric surgery, laboratory measurements to check for vitamin deficiencies were performed twice in the first year, followed by yearly control visits. Weight loss results were determined at the same frequency.

Statistical Analysis

Data are expressed as mean ± one standard deviation, unless specified otherwise. Differences in weight loss between the two age groups were analyzed using an unpaired Student's t test. Fisher's exact test was used to determine differences in categorical data. Two-sided values of $p < 0.05$ were considered statistically significant. All analyses were performed using the Statistical Package for Social Sciences (IBMM SPSS Statistics for Windows, version 21.0.0.0, IBM Corporation, Armonk, NY).

Results

A total of 103 patients in the young adult group and 103 patients in the control group were included. In the young adult group, 75 patients underwent a RYGB compared with 80 patients in the control group. The majority of patients were female: 88% in the young adult group and 81% in the control group, as listed in Table 1.

Table 1 Baseline characteristics of RYGB and SG group

	Young adults ($n = 103$)	Controls ($n = 103$)	p value
Gender (female)	88	81	0.173
Age (years)	22.7	43.2	NA
T2DM	6	6	0.674
T1DM	1	2	NA
Hypertension	2	28	< 0.001
Dyslipidemia	4	12	0.037
OSAS	3	12	0.025
Smoking	24	17	0.285
BMI	46.5	44.9	0.082
Ab. circ. (cm)	127.3	128.4	0.992
HbA_{1c} (%)	6.9	8.1	0.654

Data reported as amount of patients

OSAS, obstructive sleep apnea syndrome; *DM*, diabetes mellitus; *BMI*, body mass index in kg/m^2; *Ab. circ.*, abdominal circumference; *cm*, centimeters. *Hba_{1c}*, glycated hemoglobin A_{1c}; *NA*, not applicable

Complications

In the young adult RYGB group and the young adult SG group, one patient was readmitted to the hospital and underwent a reoperation (respectively leakage of the gastroenterostomy and bleeding). In the control group, one patient with a RYGB was readmitted and underwent a reoperation for a leakage of the gastroenterostomy and one other RYGB patient had a bleeding, which could be treated non-surgically. The < 30 days complication rate was not significantly different between the two age groups ($p = 0.56$) (Table 2).

In the young adult group, 27 patients (26%) had a complication > 30 days after surgery, compared with 22 patients (21%) in the control group, which was not significantly different ($p = 0.414$). After exclusion of cholecystectomy as a complication, the total complication rate in the young adult group was 11.6% (12 patients) compared with 10.8% (11 patients) in the control group ($p = 0.332$). Seven patients (9.3%) from the young adult RYGB group had chronic abdominal complaints, possibly due to intermittent herniation, which was a reason for diagnostic laparoscopy, compared with eight patients (10%) in the control group. An internal herniation was present in four young adults (5.3%) compared with three patients (3.8%) in the control group, which was not significantly different ($p = 0.34$).

Nutritional Status

In the majority of patients in both groups, a vitamin D deficiency was identified. All other preoperatively identified vitamin deficiencies, including vitamin D, were treated according to a standard regimen that was developed in our center. The cumulative numbers of vitamin deficiencies after 36 months are listed in Table 3.

Weight Loss

In the first year, a %TBWL of 33.9 (± 8) in the young adult RYGB group was achieved, compared with 31.8 (± 7) in the control RYGB group ($p = 0.06$). In the second year, the young adult RYGB group achieved a %TBWL of 35.2 (± 9) compared with 32.3 (± 7) in the control RYGB group ($p = 0.04$), and in the third year, this was 34 (± 9) compared with 30.3 (± 9) ($p = 0.03$), respectively (Supplementary Table 1).

In the young adult SG group, a %TBWL of 33.3 (± 11) was achieved after 1 year, compared with 32.2 (± 6) in the control SG group ($p = 0.57$). In the second year, the young adult SG group achieved a %TBWL of 33.2 (± 11) compared with 30.2 (± 6) in the control SG group ($p = 0.26$), and in the third year, this was 29.3 (± 10) compared with 27.5 (± 7) ($p = 0.55$), respectively. Preoperative body weight in the young adult RYGB group was 133.8 kg (± 19) compared with 142.3 kg

Table 2 Complications after RYGB or SG

	Young adults ($n = 103$)	Controls ($n = 103$)	p value
< 30 days complication	3	3	
Readmission	2	1	0.563
Reoperation	2	1	0.563
Leakage	1	1	NA
Bleeding	1	1	NA
Wound infection	0	0	NA
Thrombosis	0	0	NA
Stenosis	1	0	0.319
Mortality	0	0	NA
Other	1*	1#	NA
> 30 days complication	27	22	0.414
Reoperation:	19	18	0.666
- Cholecystectomy	16	11	0.303
- Hernia cicatricalis	2	2	NA
- Suspected internal herniation	3	5	0.480
- Present internal herniation	4	3	0.341
Other:			
- Ulcer	1	2	0.563
- Obstipation	0	4	0.044
- Chronic diarrhea	1	1	NA

Data listed as amount of patients with a complication after RYGB or SG; other complication < 30 days

NA not applicable

*Persistent fistula for which the patient received an endoprosthesis followed by surgical correction; #Acute cholecystitis 5 days after surgery for which a laparoscopic cholecystectomy was performed

Table 3 Nutritional deficiencies

	Young adults ($t = 0$)	Controls ($t = 0$)	p value	Young adults ($t = 36$)	Controls ($t = 36$)	p value
RYGB						
Anemia	4	5	0.810	17	14	0.354
Ferritin	3	3	NA	23	18	0.713
Vitamin B12	15	14	0.687	36	28	0.379
Vitamin D	42	48	0.735	19	18	0.402
SG						
Anemia	3	2	0.788	3	2	0.879
Ferritin	1	2	0.515	8	4	0.380
Vitamin B12	4	4	NA	8	3	0.198
Vitamin D	12	9	0.419	10	5	0.294

Anemia: in case of hemoglobin for female < 7.4 mmol/L or for male < 8.4 mmol/L; iron deficiency in case of ferritin level < 20 nmol/L; vitamin B12 deficiency in case of level < 150 pmol/L; vitamin D deficiency in case of level < 50 nmol/L; $t = 0$: number of patients with a deficiency prior to surgery; $t = 36$: number of patients with a deficiency during 3 years of follow-up (cumulative number)

NA not applicable

(± 26) in the young adult SG group ($p = 0.07$). No significant difference in %TBWL between the RYGB and the SG in the young adults group could be identified after 1 ($p = 0.754$), 2 ($p = 0.804$), and 3 years ($p = 0.476$). In the control group, the preoperative body weight in the RYGB group was 131.8 kg (± 21) compared with 132.9 kg (± 19) in the SG group ($p = 0.82$). Similar to the young adults' group, no significant difference in %TBWL between the RYGB and SG could be determined after 1 ($p = 0.610$), 2 ($p = 0.442$), and 3 years ($p = 0.453$) in the control group (Fig. 1).

Comorbidities

After surgery, both groups achieved a remission rate of 100% of type 2 diabetes mellitus (T2DM). In the young adults' group, antihypertensive medication could be discontinued in 100% of patients, compared with 75% in the control group. Complete remission of dyslipidemia (DL) was achieved in 98% in both groups.

Quality of Life

The scores on all topics of the Short Form (SF)-36 quality of life questionnaire, except emotional well-being, were significantly improved in both groups, within the 3 years of follow-up, but not significantly different between the two age groups (Fig. 2).

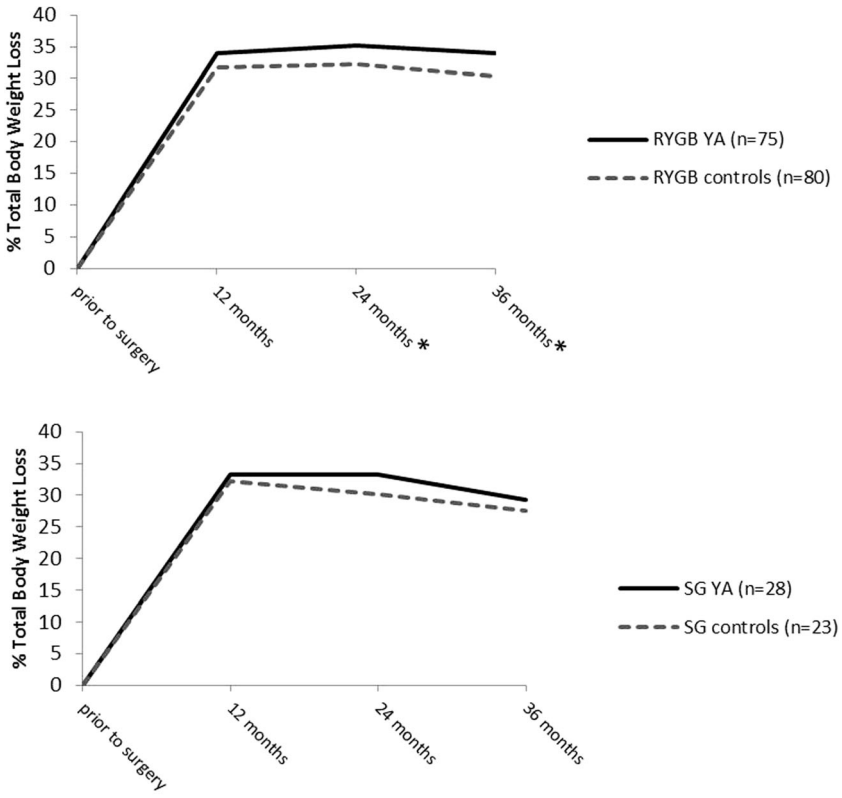

Fig. 1 Percentage total body weight loss after RYGB and SG. YA: young adult patients; *Statistical significant difference: $p = 0.039$ after 24 months and $p = 0.034$ after 36 months

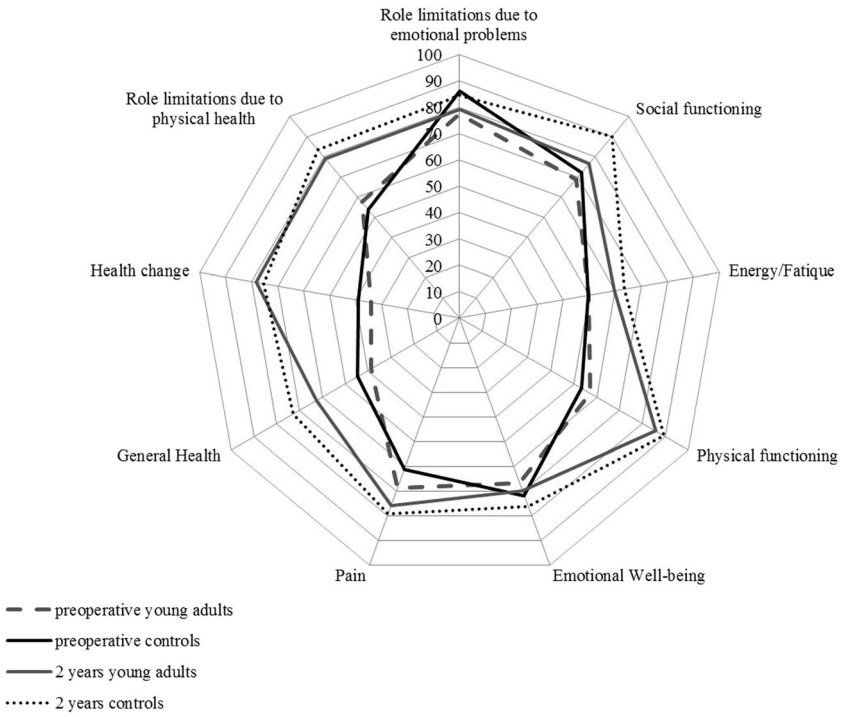

Fig. 2 Quality of life scores after RYGB and SG. Polar chart: scores of the Short Form (SF)-36 questionnaire

Discussion

Nowadays, the most common bariatric procedures performed in adults are SG and RYGB. Sustainable weight loss, resolution of comorbidities, and an increase in health-related quality of life are achieved in the majority of patients [7, 8]. Literature shows that differences in weight loss among age groups are reported in favor of patients < 50 years of age compared with the elderly [6]. The overall total amount of weight loss achieved is reported to be approximately 25–30% on the long term [8, 9]. Our data show a significant higher amount of weight loss during the 3 years of follow-up in the young adult RYGB group compared with the control group. The higher amount of weight loss seen in the young adult RYGB group was not expected and has not been previously described in the literature. Theoretically, younger patients have a relative shorter exposure to the negative effects of obesity, which could be of influence to their metabolic state and the ability to lose weight. RYGB is known to result in extended changes in gut hormone and bile acid levels and factors influencing different parts of the metabolic process, such as the microbiome [10]. We find it very feasible that this effect is even more pronounced at a younger age, resulting in more weight loss. Besides metabolic factors, differences in the levels of exercise and lifestyle could also possibly alter the weight loss response. Unfortunately, this information was not available in our study, but would be of interest in future research. The follow-up rate was comparable for both age groups, so the difference in weight loss is less likely to be attributable to the compliance to the program. The clinical relevance of this higher amount of weight loss after RYGB in younger patients will have to be determined. The 3% TBWL difference roughly correlates with 4–5 kg on average. If this can be attributed to the age difference, then this is a significant finding. However, clinical relevance hardly ever comes from one aspect in metabolic surgery alone but is the sum of smaller significant factors. We expect future research with larger patient cohorts and long-term follow-up in younger patients might add to the clinical value.

After analyzing both age groups separately, no significant differences in %TBWL after RYGB compared with SG could be identified. The limited amount of patients in the SG group, however, counters the possibility to draw a definitive conclusion, and further research with a higher number of participants in the SG group is recommended. According to Felsenreich et al., a large number of patients suffer in the long term from symptomatic gastrointestinal reflux disease after SG [11]. This is potentially harmful, since it increases the risk to develop a Barret esophagus and ultimately gastroesophageal cancer. It is unclear whether younger patients could be of greater risk due to extended exposure to this harmful effect.

Our study is focusing on several secondary outcome measures as well, since the effect of bariatric surgery is not limited to weight loss alone. In the literature, there is a lack of studies focusing on these combined outcomes of bariatric surgery in patients from younger age groups. The

high remission rates of comorbidities in the young adult group are possibly attributed to a shorter duration and less severity of disease, which is illustrated by a relative lower use of medication. Our reported results are comparable with the literature [12–15].

Weight loss is associated with improved scores on health-related quality of life, especially physical functioning [16]. Our data showed a significant improvement in the majority of topics of the SF-36 in both groups, but no significant differences between the two age groups could be identified. The preoperative significant difference in emotional well-being and general health is difficult to interpret, since the underlying mechanisms behind these differences have not been fully understood. Hypothetically, the difference in age itself could be the discriminating factor, since the level of maturity could alter the ability of using the SF-36 adequately [17, 18]. New studies focusing on quality of life in this specific age group could possibly contribute to more insight.

No significant differences in safety of the RYGB and SG could be identified, in terms of short- and long-term complication rates. In both age groups, a relatively high amount of patients underwent a reoperation, due to chronic abdominal complaints possibly due to an (intermittent) internal herniation. In four young adults and three patients of the control group, an actual internal herniation was seen during laparoscopy. In our center of excellence diagnostic, re-laparoscopy has proved to be useful in the differential diagnosis of chronic abdominal pain after metabolic surgery. One of the reasons is the high accuracy in diagnosing internal hernias after RYGB where CT scan often cannot. This explains the relatively high number of reoperations in our series. Although mesenteric defects are routinely closed with staples during primary surgery, internal hernias are detected quite regularly. The presented incidence of internal hernias does not deviate from the literature but certainly leaves room for improvement.

Common complications in the long term are nutritional deficiencies, with the highest incidence within the first 2 years after bariatric surgery [19]. Our data shows a postoperative cumulative risk of development of anemia which significantly increased in both age groups with approximately 15% (data not shown), but no differences between the two groups could be identified. The overall incidence of vitamin deficiencies was higher in the young adult group, especially for vitamins D and B12. Studies focusing on the occurrence of vitamin deficiencies after bariatric surgery illustrated the importance of nutritional monitoring with the administration of multivitamins and mineral supplements in the prevention of deficiencies and related health problems [20]. Our reported higher rates of deficiencies in the young adult group could be due to a lower therapy compliance rate, since a younger age is related to lower attendance at medical bariatric follow-up care [21]. This might be the case for therapy compliance as well. The high number of women in the young age group, with potential pregnancies in the future, illustrates the need of highlighting the importance of therapy compliance of multivitamins in the bariatric program, to prevent nutritional deficiencies and potential pregnancy-related problems.

We acknowledge the partly retrospective study design has introduced a few limitations, which could be obviated by a total prospective study design. Unfortunately, we did not succeed to match the patients for type of surgery in 100% of the cases. As a consequence of the age groups we studied, we were not able to match patients for other comorbidities than T2DM, such as hypertension and dyslipidemia. The number of patients with T2DM was comparable between the two age groups which makes an effect on the difference in %TBWL less likely. As mentioned earlier, the low number of patients with SG in both age groups counters the possibility to draw definitive conclusions about the effects of this bariatric procedure. It could be of future interest to expand these numbers. The same applies for the measured quality of life. The differences between the two age groups were not significant, but this could be due to under powering. The majority of follow-up laboratory values for T2DM were missing because of our referral system. This was partially covered by data on medication use, which was available for all of the T2DM patients. A strength of this study is that we are able to report all outcomes after bariatric surgery for both age groups, which can be a starting point for future research in which age differences can be further elaborated.

Conclusion

Bariatric surgery is safe and effective in young adults, and results are even better compared with age groups in which bariatric surgery is most often performed. The high remission rate of obesity-related comorbidities shows the importance of effective treatment options, inducing sustainable weight loss in preventing the damaging effect of chronic metabolic diseases at an early stage. It is important to emphasize the need to use multivitamins in the years after surgery, especially among young adults, with a high number of young fertile women with possible pregnancies in the future.

Compliance with Ethical Standards

This study was approved by the national ethical committee and the local institutional review board. Written informed consent was obtained from all participants.

Conflict of Interest The authors declare that they have no conflict of interest.

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